CYTOLOGICAL STUDIES IN PASPALUM, GROUP SETACEA (GRAMINEAE)[1]

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The *Setacea* group of the genus *Paspalum* consists of a network of closely related taxa which are taxonomically difficult. Chase (1929) recognized 10 species in the group but acknowledged that they are poorly defined and appear to intergrade. This study was made to obtain information to be used in a toxonomic revision of the group. The names used for the taxa are according to Chase's concept. My concept of the taxa is to be published in another paper.

CHROMOSOMES

Immature inflorescences were collected in the field or from greenhouse transplants, killed in a 3:1 alcohol-glacial acetic acid solution, and the anthers squashed in aceto-carmine. The chromosome counts were usually made at diakinesis in pollen mother cells. Photomicrographs were made of microsporocytes with chromosomes distributed so that they were countable. Some slides representing each taxon were made permanent by McClintock's (1929) method. Voucher specimens are deposited in the University of Georgia and the Stephen F. Austin State College herbaria.

A summary of chromosome counts made during this study and by previous investigators is given in Table 1. In all the plants that I studied the microspores contained 10 chromosomes and meiosis appeared normal. Differences in chromosome size and morphology within or between taxa were slight. Drawings made by tracing photomicrographs of chromosomes of each species (sensu Chase, 1929) are shown in Figures 1 to 10.

Chromosome counts, all gametic, for *P. debile* Michx., *P. longepedunculatum* LeConte, *P. propinquum* Nash, *P. psammophilum* Nash, *P. rigidifolium* Nash, and *P. stramineum* Nash are presented for the first time. Somatic counts previously reported for *P. ciliatifolium* Michx., *P. pubescens* Muhl., *P. setaceum* Michx., and *P. supinum* Bosc varied from 20 to 80 with different counts for the same species (see Table 1).

Darlington and Wylie (1955) reported the basic chromosome numbers 10 and 12 for *Paspalum*. Forbes and Burton (1961) suggested the base number 10 may have been derived from some lower ancestral base number, possibly 5 or 6, because of strong secondary associations of bivalents noted in their investigations with *P. almum* Chase. Some of

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my preparations suggested secondary associations. Additional studies are required to confirm this suggestion. This study disclosed no chromosomal data that I consider to be useful in distinguishing between the *Setacea* taxa.

EMBRYO SAC DEVELOPMENT

A better concept of the taxa might be possible if the mode of reproduction could be determined. Apomixis, which occurs in some *Paspalum* species, was suspected in *Setacea* because of morphological uniformity within its component taxa where they grow sympatrically and because of similarity of progeny to the maternal parents in some progeny tests. The following study was conducted to determine whether or not the *Setacea* taxa reproduce by apomixis.

Immature inflorescences collected in the field or greenhouse were killed and fixed in a 3:1 absolute alcohol-glacial acetic acid solution. The material was stored in 70% alcohol at 5°C until dehydration was begun. Dehydration was completed with a tertiary butyl alcohol series. The material was infiltrated with paraffin, sectioned at thicknesses of 15 to 17 microns with a rotary microtome, and stained with safranin-fast green. Twelve to twenty spikelets per plant were sectioned. Twenty-two plants representing the ten taxa were studied. The slides were examined microscopically to ascertain whether or not multiple embryo sacs were present.

None of the material studied showed more than one embryo sac. Embyro sac development in *Setacea* is the *Polygonum* type except the antipodals usually form several cells rather than three.

Apomixis was reported in *Paspalum* by Burton (1948), Smith (1948), Bashaw and Holt (1958), Brown and Emery (1958), Forbes (1960), and Snyder (1957, 1961). Brown and Emery (1958) reported normal embryo sac development for *P. pubescens*, the only *Setacea Paspalum* which apparently had been investigated prior to this study.

The type of apomixis detected in *Paspalum* thus far is somatic apospory followed by pseudogamy. Usually one or more nucellar cells adjacent to the megaspore mother cell begins to enlarge and one of the cells usually develops into a functional embryo sac. A nucellar embryo sac may consist of an egg, two synergids, two polars, and several antipodals as in *P. secans* Hitchc. and Chase (Snyder, 1957) or the synergids and antipodals may be absent as in *P. dilatatum* Poir. (Bashaw and Holt, 1958). Fertilization of the polar nuclei is believed to be necessary for the development of endosperm, but the embryo develops from an unreduced, unfertilized egg.

The failure to detect multiple embryo sacs in *Setacea* suggest that they reproduce sexually, although stages representing actual fertilization of the egg or polars were not observed. The formation of a single embryo sac by generative apospory, however, is not precluded by my data; but since the chromosome studies indicated meiosis to be normal, and since the taxa appear to be diploid, sexual reproduction, rather than apomixis, seems likely. If apomixis is dismissed as a possible mode of reproduction, the similarities of offspring to maternal parents in some progeny tests are best explained by suggesting self-fertilization as the usual method of reproduction. Further investigations are needed to establish the method of reproduction.

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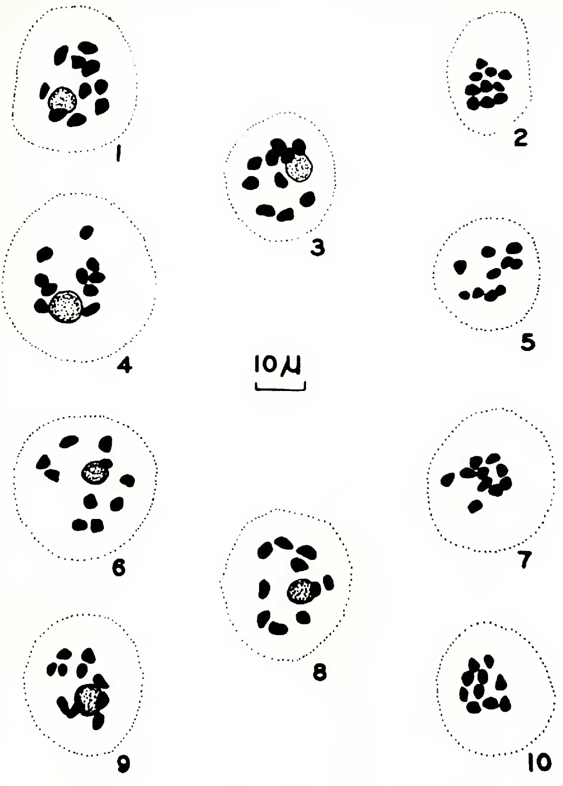

Fig. 1-10. Chromosomes of *Setacea* species (sensu Chase, 1929) at diakinesis.—Fig. 1. *P. ciliatifolium*, Banks 1339.—Fig. 2. *P. debile*, Banks 1625.—Fig. 3. *P. longepedunculatum*, Banks 891.—Fig. 4. *P. propinquum*, Banks 1726.—Fig. 5. *P. psammophilum*, Banks 1507.—Fig. 6. *P. pubescens*, Banks 1525.—Fig. 7. *P. rigidifolium*, Banks 1314.—Fig. 8. *P. setaceum*, Banks 1451.—Fig. 9. *P. stramineum*, Dwyer 16 Aug. 1961.—Fig. 10. *P. supinum*, Banks 906.

TABLE 1

SUMMARY OF CHROMOSOME NUMBERS OF THE *SETACEA* PASPALUMS

Species (Sensu Chase, 1929)	Gametic	Somatic	Investigator	Plants examined for this study[1] All gametic chromosome numbers were 10
ciliatifolium[2]		20	Burton (1940)	L-65, Glynn Co., Ga.; 933, 934, Jefferson Co., Fla.;
		20	Brown (1948)	954, Taylor Co., Fla.; 964, Alachua Co., Fla.; 984, Wheeler Co., Ga.; 1339, Columbia Co., Fla.; 1412, Cooke Co., Tex.; 1413, Warren Co., Miss.; 1570, Taylor Co., Ga.; 1630, Santa Rosa Co., Fla.; W. H. Duncan 21888, Monroe Co., Fla.; D. G. Randolph R-2, Jack Co., Tex.
debile				832, Santa Rosa Co., Fla.; 912, Leon Co., Fla.; 1160, Hardee Co., Fla.; 1440, Camden Co., N. C.; 1616A, 1619, 1625, Santa Rosa Co., Fla.; 1713, Bay Co., Fla.; 1747, Levy Co., Fla.; 1885, Travis Co., Tex.; 3670, Brooks Co., Tex.

[1] Numbers are my collections except where otherwise indicated.

[2] Darlington and Wylie (1955) listed *P. epile* without author, as $2n=80$, as determined by Saura (1941). *P. epile* Nash is a synonym of *P. ciliatifolium*. The plant determined by Saura was *P. epile* Parodi (*P. parodianum* Hennr.) and is not synonymous with *P. ciliatifolium*.

TABLE 1 (Continued)

Species (Sensu Chase, 1929)	Gametic	Somatic	Investigator	Plants examined for this study[1] All gametic chromosome numbers were 10
longepedunculatum				891, Bay Co., Fla.; 1145, 1146, Lake Co., Fla.; W. H. Duncan, 21844, Collier Co., Fla.
propinquum				1726, Taylor Co., Fla.; 1733, Dixie Co., Fla.
psammophilum				1459, Burlington Co., N. J.; 1507, 1516, Camden Co., N. J.
pubescens[3]	10 10		Church (1929) Gould (1958)	L-25, L-31, L-35, Laurens Co., Ga.; 974, Putnam Co., Fla.; 994, Oglethorpe Co., Ga.; 1017, Clarke Co., Ga.; 1437, Martin Co., N. C.; 1439, Camden Co., N. C.; 1452, Gloucester Co., N. J.; 1525, Dinwiddie Co., Va.; 1531, Nash Co., N. C.; 1898, Nacogdoches Co., Tex.
rigidifolium				1158, Polk Co., Fla.; 1314, Marion Co., Fla.; 1746, Levy Co., Fla.; 1773, Pinellas Co., Fla.

[3] Brown (1948) reported 2n=60 for *P. pubescens*. His voucher specimen (2605), which I examined in the Herbarium of the University of Texas, is really *P. longipilum* Nash.

TABLE 1 (Continued)

Species (Sensu Chase, 1929)	Gametic	Somatic	Investigator	Plants examined for this study[1] All gametic chromosome numbers were 10
setaceum		50	Kirshnaswamy (1940)	L-19, Wilkinson Co., Ga.; L-24, Laurens Co., Ga.;
		40	Brown (1948)	L-146, Taylor Co., Ga.; 770, Pike Co., Ala.; 870, Okaloosa Co., Fla.; 908, Leon Co., Fla.; 1430, Onslow Co., N. C.; 1451, Gloucester Co., N. J.; 1460, Burlington Co., N. J.; 1524, Dinwiddie Co., Va.; 1536, Baldwin Co., Ga.; 1682, Baldwin Co., Ala.; 1790, Putnam Co., Fla.
stramineum				1411, 1815, Payne Co., Okla.; 1886, 1889, Travis Co., Tex.; 1895, Burnet Co., Tex.; D. Dwyer Aug. 16, 1961, Payne Co., Okla.
supinum		20	Burton (1942)	906, Leon Co., Fla.; 953, Taylor Co., Fla.; 1620, Santa Rosa Co., Fla.; 1668 Jackson Co., Miss.